The Journal of Laryngology & Otology

cambridge.org/jlo

Feasibility of an enhanced low-fidelity ear simulator for otomicroscopy training

Megan Allman and David Owens

ENT Department, University Hospital of Wales, Cardiff, Wales, UK

Short Communication

Megan Allman takes responsibility for the integrity of the content of the paper

Presented at ENT Wales Annual Meeting, 21 October 2022, Saundersfoot, Wales, UK.

Cite this article: Allman M, Owens D. Feasibility of an enhanced low-fidelity ear simulator for otomicroscopy training. *J Laryngol Otol* 2024;**138**:808–810. https://doi.org/10.1017/S0022215123002359

Received: 29 September 2023
Revised: 15 November 2023
Accepted: 23 November 2023
First published online: 17 January 2024

Keywords:
Medical education; postgraduate education; undergraduate medical education; teaching; otology

Corresponding author:
Megan Allman;
Email: meganallman@doctors.org.uk

Abstract

Objective. Otoscopic skills are essential for ENT doctors. Early-stage doctors develop skills whilst treating patients, with minimal teaching, potentially increasing risk to patients. Simulation allows skill development without patient risk; however, simulation often requires subjective expert review of technique. This study compared enhanced low-fidelity simulation with performance feedback against standard simulation using a basic otoscopy skills simulator.

Methods. Two low-fidelity ear simulators were created: a basic model without feedback and an enhanced model which alarms when the aural instrument tip touches the canal wall. Participants were evaluated in a randomised crossover pilot study, using both models to assess whether objective feedback reduced tip touches.

Results. The enhanced simulator reduced tip touches more than the control model, suggesting better and more sustained skill uptake. Participants reported that the enhanced model improved learning.

Conclusion. Enhanced low-fidelity models provide a low-cost opportunity to improve otoscopy skills without patient risk or the need for subjective expert feedback.

Introduction

Otomicroscopy is a core skill for ENT junior doctors, and it requires practice and experience to master. Despite otomicroscopy being one of the most commonly performed procedures in ENT, it is not risk-free.[1,2] Evidence of the complication rate is limited; however, in one prospective study, 55 per cent of patients reported minor adverse effects from microsuction.[3] Complications include pain, trauma to the ear canal, minor bleeding and, rarely, perforation of the tympanic membrane.[4,5]

The most effective way of learning new skills is via feedback-reinforced repetition.[6] Most junior doctors are expected to learn and practise otomicroscopy skills directly on real patients, often with limited teaching, and, specifically, limited simulation training; therefore, patients may be at an increased risk of harm during early development of these skills by inexperienced junior doctors.[7]

Simulation is used throughout medical education, as it allows the development of skills prior to patient interaction, therefore minimising any potential patient risk associated with early skill acquisition.[8] Low-fidelity ear simulator models exist in the literature; however, one issue for most low-fidelity simulators is that they require subjective expert review of technique to receive performance feedback, reducing users' ability to practise and improve independently.[1,9,10] There is compelling evidence of the benefit of receiving performance feedback when learning new skills.[11] One recent study found that immediate auditory feedback is superior to other types of feedback for basic surgical skills acquisitions.[12]

This paper discusses an enhancement to low-fidelity ear simulation that provides objective performance feedback for otomicroscopy skills.

Aim

The study aimed to assess the value of enhanced low-fidelity simulation against standard simulation using a basic otoscopy skills simulator for teaching otomicroscopy skills.

Materials and methods

A low-fidelity ear simulator model was assembled (Figures 1 and 2) based on a previously published model by Shenton and Aucott.[9]

The model consists of a cardboard bowl, a 2 ml syringe, and a piece of copper pipe with a diameter of 0.7 mm cut with an angle to 2.5 cm to simulate the ear canal. The cut finger of a latex glove was stretched over its angled end to create the tympanic membrane. The handle of malleus was drawn onto the tympanic membrane. A second model was created, which was enhanced with the addition of a simple circuit consisting of a battery, buzzer, and copper wiring to connect the model components to the copper

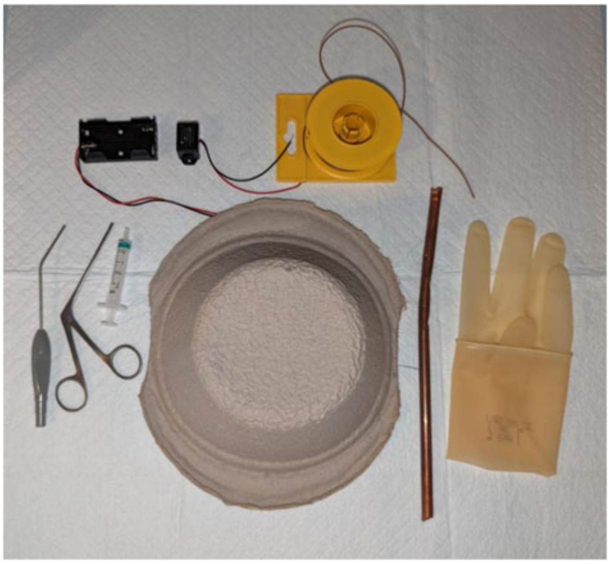

Figure 1. Components needed to build an enhanced low-fidelity ear simulator.

pipe and otomicroscopy instruments (aural microsuction and crocodile forceps). When the instrument tip touches the ear canal, which is painful and risks canal trauma in real patients, the buzzer alarms, thus providing objective performance feedback to the user. The instrument arms were painted to ensure that only the tip of the instrument set off the buzzer.

The model was tested on non-expert participants using a microscope for microsuction and foreign body removal tasks, in a crossover design pilot study. Each participant had five attempts with the buzzer as feedback (enhanced model), and five attempts without the buzzer (basic model). Participants were randomly assigned to groups: half of the participants started with the basic model and then switched to the enhanced model, and half of the participants started with the enhanced model and then switching to the basic model. The number of times the instrument tip touched the ear canal on each attempt was recorded. Additional user experience feedback was gathered via a questionnaire. Descriptive statistics were used for the results.

Results

There were eight non-expert participants (two medical students and six junior doctors). The overall average number of touches per attempt for the first model used was 6.13 on the first attempt and 2 touches on the fifth attempt. The overall average number of touches for the second model used was 4.5 on the first attempt and 0.88 touches on the fifth attempt.

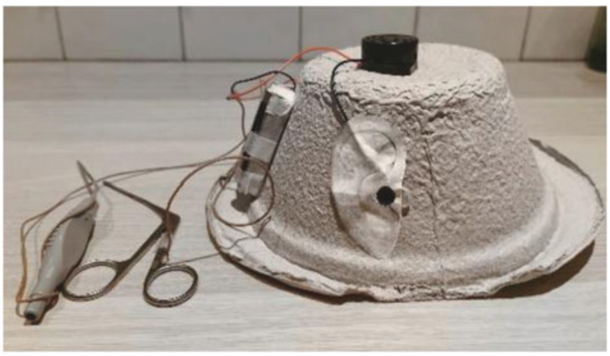

Figure 2. Enhanced low-fidelity ear simulator with buzzer for feedback.

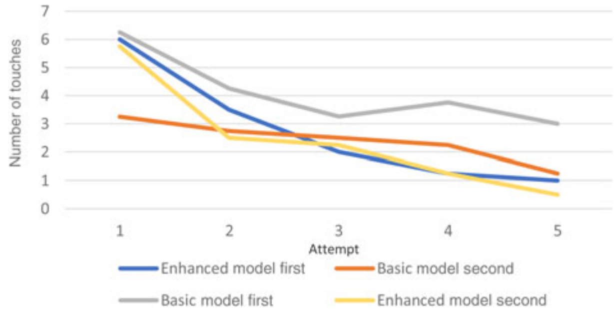

Figure 3. Average number of touches per attempt, demonstrating quicker reduction of touches when using the enhanced simulator.

Participants who used the enhanced model first had an average of 6 touches on their first attempt and 1 on their fifth attempt; on their subsequent attempts with the basic model, they had an average of 3.25 touches on the first attempt and 1.25 touches on the fifth attempt. Participants who started with the basic model had an average of 6.25 touches on their first attempt, and 3 touches on their final attempt. When they transferred to the enhanced model, they had an average of 5.75 touches on their first attempt and 0.5 touches on the fifth attempt. The results are demonstrated in Figure 3.

All participants felt that the enhanced model was a useful tool for learning and practising otomicroscopy skills. They all increased their confidence in otomicroscopy and felt that the objective buzzer feedback improved their learning over that of the basic model.

Discussion

The results of this study suggest that skill uptake occurs more quickly with the enhanced model which provides objective feedback, compared with the basic simulator model. This is evidenced by a quicker reduction in the number of touches per attempt and a lower average number of touches in the final attempt, 3 and 0.5 touches for the basic and enhanced models, respectively. However, our data also suggest that skills picked up whilst using the enhanced model are sustained when subsequently using the basic model, beyond those who used the basic model first. This is demonstrated by the average number of 3.25 touches when using the basic model after the enhanced model, compared with an average of 5.75 touches for participants using the enhanced model after using the basic model. The participants who started with the basic model did not show a sustained improvement when moving to the enhanced model; however, their skills appear to improve quickly once using the enhanced model, reaching an average of 0.5 touches on their final attempt.

We can infer that after using the enhanced model with performance feedback, the improvement in participants' skills is maintained. Such benefit would likely be conferred to patients in a real setting, who would be less likely to experience pain and minor trauma during microsuction associated with the instrument touching the ear canal.

The model was well accepted by all users, who felt that the enhanced model improved their skill learning and was a more useful otomicroscopy teaching tool than the basic model.

There are several benefits to this enhanced model as a training aid for teaching otomicroscopy skills. The model is simple, quick to make and easily reproducible. The components are readily available in the hospital or can be purchased at a low cost. The simulator, made using the previously described guide,[9] provides a grossly anatomically correct model of the external auditory canal. This allows junior trainees to practise and develop skills including otomicroscopy, microsuction and foreign body removal. These skills can be practised with objective performance feedback and consequently improved prior to real patient interaction, thereby minimising risks to patients associated with otomicroscopy.[3,4]

There are a small number of do-it-yourself ear training models available, as described in the literature.[1,9,10] However, this model improves on the previously described models with the addition of objective auditory feedback on performance. Receiving performance feedback is essential for developing skills in surgery.[13] Specifically, receiving immediate feedback has been shown to be most beneficial for the quick uptake of surgical skills.[12] One recent study demonstrated the benefit of auditory feedback using different pitched tones to help improve position accuracy in image-guided needle biopsy.[14] Their results showed that the addition of auditory feedback to a standard visual display resulted in accurate placement and reduced reliance on screen viewing when placing the needle.

There are some limitations to the enhanced model. Firstly, as it uses a brushed copper piping to represent the external auditory canal, the surface has a somewhat shiny appearance, which may cause some glare or reflection whilst using the microscope light. We did not find that this impeded use of the model with the microscope. However, to overcome this issue, the inside of the copper pipe could be painted with black conductive paint. Further improvement to the model would be achieved if touching the tip of the instrument against the tympanic membrane, which would risk pain and perforation in a real setting, also caused the buzzer to alarm. Furthermore, there were only a small number of participants in the study, preventing more in-depth statistical analysis. This was a pilot study conducted to assess the feasibility of the enhanced model and determine whether it would be a useful training tool for developing otomicroscopy skills. We plan to undertake a larger, powered study to test for true statistical significance.

Conclusion

Otomicroscopy requires practice and experience to minimise risk to patients. The risk of complications from otomicroscopy may be increased when juniors are learning these skills. This enhanced low-fidelity model delivers objective performance feedback, providing an effective, risk-free training tool to teach ENT junior doctors otomicroscopy skills. We hope that by utilising this enhanced basic model, junior doctors in ENT can improve their learning of otomicroscopy skills.

Competing interests. None declared

References

1 Jesudason WV, Smith I. How we do it: the Bradford grommet trainer: a model for training in myringotomy and grommet insertion. *Clin Otolaryngol* 2005;**30**:371–3
2 Huang C, Cheng H, Bureau Y, Agrawal SK, Ladak HM. Face and content validity of a virtual-reality simulator for myringotomy with tube placement. *J Otolaryngol Head Neck Surg* 2015;**44**:40
3 Addams-Williams J, Howarth A, Phillipps JJ. Microsuction aural toilet in ENT outpatients: a questionnaire to evaluate the patient experience. *Eur Arch Otorhinolaryngol* 2010;**267**:1863–6
4 Pothier DD, Hall C, Gillett S. A comparison of endoscopic and microscopic removal of wax: a randomised clinical trial. *Clin Otolaryngol* 2006;**31**:375–80
5 Schmiemann G, Kruschinski C. Complication rate of out-patient removal of ear wax: systematic review of the literature [in German]. *HNO* 2009;**57**:713–18
6 Bosse HM, Mohr J, Buss B, Krautter M, Weyrich P, Herzog W *et al*. The benefit of repetitive skills training and frequency of expert feedback in the early acquisition of procedural skills. *BMC Med Educ* 2015;**15**:22
7 Fisher EW, Pfleiderer AG. Is undergraduate otoscopy teaching adequate? An audit of clinical teaching. *J R Soc Med* 1992;**85**:23–5
8 Tan SSY, Sarker SK. Simulation in surgery: a review. *Scott Med J* 2011;**56**:104–9
9 Shenton C, Aucott W. How I do it: a simulator of the ear for developing otomicroscopy skills during the coronavirus disease 2019 pandemic. *J Laryngol Otol* 2020;**134**:1022–5
10 Paraiso R, Downey L. A simple method for teaching myringotomy and ventilation tube insertion. *Ear Nose Throat J* 2011;**90**:94–6
11 Zhou Y, Shao W, Wang L. Effects of feedback on students' motor skill learning in physical education: a systematic review. *Int J Environ Res Public Health* 2021;**18**:6281
12 Al Fayyadh MJ, Hassan RA, Tran ZK, Kempenich JW, Bunegin L, Dent DL *et al*. Immediate auditory feedback is superior to other types of feedback for basic surgical skills acquisition. *J Surg Educ* 2017;**74**:e55–61
13 El Boghdady M, Alijani A. Feedback in surgical education. *Surgeon* 2017;**15**:98–103
14 Black D, Hettig J, Luz M, Hansen C, Kikinis R, Hahn H. Auditory feedback to support image-guided medical needle placement. *Int J Comput Assist Radiol Surg* 2017;**12**:1655–63